(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 243 105 A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 87303383.1

(22) Date of filing: 16.04.87

(51) Int. Cl.4: D 04 B 1/00
B 29 C 67/14

(30) Priority: 18.04.86 GB 8609491

(43) Date of publication of application:
28.10.87 Bulletin 87/44

(84) Designated Contracting States: DE ES FR GB IT

(71) Applicant: COURTAULDS PLC
18, Hanover Square
London W1A 2BB (GB)

(72) Inventor: Robinson, Frank
9 Field Close
Breaston Derbyshire (GB)

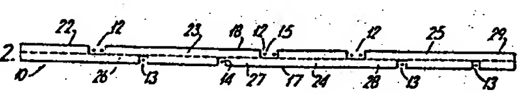
Williams, Dennis John
6 West Bank Avenue
Derby Derbyshire (GB)

(74) Representative: Newby, John Ross et al
J.Y. & G.W. Johnson Furnival House 14/18 High Holborn
London WC1V 6DE (GB)

(54) Composite element and reinforcement therefor.

(57) A knitted fabric (10) adapted to serve as reinforcement for a composite element, is characterised in that the fabric (10) has at least one linear region (12, 13) structured so as to constitute a natural fold line in the fabric so that by folding the fabric at the or each of the said lines (12, 13) it can be formed into a configuration suitable for a composite element reinforcement. The or each fold line can extend in the wale or course direction and can be curved.

Fig.2



EP 0 243 105 A1

Description

Composite Element and Reinforcement Therefor

Technical Field

This invention relates to a composite element and to reinforcement therefor. A composite element comprises reinforcing material impregnated with, or embedded in a matrix of, synthetic resin and the present invention is concerned with the manufacture of the reinforcing material and with composite elements produced using the reinforcing material so manufactured.

Discussion of Prior Art

The use of knitted fabric as reinforcement for composite elements has been proposed before. The present invention proposes that such reinforcement should be formed to a desired configuration by folding weft or warp knitted fabric, thus enabling a great variety of shapes of reinforcement to be formed using very similar knitting operations on similar knitting machines.

Summary of the Invention

According to the invention, a knitted fabric to serve as reinforcement for a composite element has at least one linear region structured so as to constitute a natural fold line in the fabric so that by folding the fabric at the or each of the said fold lines it can be formed into a configuration suitable for a composite element reinforcement.

The invention includes a reinforcement for a composite element whenever formed from fabric as described above.

The invention also consists in a composite element including reinforcement comprising a knitted fabric with at least one linear region which is structured so as to constitute a natural fold line in the fabric, the fabric being folded at the or each of the said fold lines to form it to such a configuration that it is adapted to serve as reinforcement in the composite element.

A linear region in a warp or weft knitted fabric according to the invention may have a width equal to the gap between adjacent wales but may be wider. Normally a width of two or three wale spacings will be the maximum required. The wider the region the greater the angle of fold which will tend to occur at the region. In some cases it may be advantageous that a fabric according to the invention has relatively narrow and relatively wide fold lines so that the natural angle of fold will be greater at some lines than at others.

Advantageously, the bulk of a weft knitted fabric according to the invention may comprise a double jersey structure, that is a weft knitted structure in which loops are pulled to both faces of the fabric. A linear region constituting a fold line in the fabric may then comprise a region in which the balance of loops in the two fabric faces is broken, possibly in such a way that, in the region constituting the fold line, loops are pulled to one face of the fabric only.

Brief Description of the Drawings

The invention will be further described with reference to the accompanying drawings in which:-

Figure I illustrates diagrammatically the knitted structure of a part of a weft knitted fabric according to the invention,

Figure 2 is another type of diagram showing the whole of a cross-section through the fabric of Figure I,

Figure 3 is a diagrammatic cross-section illustrating a reinforcement formed by folding the fabric of Figures I and 2,

Figures 4 to 9 are diagrammatic cross-sections illustrating further reinforcements formed by folding other fabrics according to the invention,

Figure IO is a lapping diagram for a warp knitted fabric according to the invention,

Figure II a schematic cross-section through a fabric knitted in accordance with the lapping movements shown in Figure IO, and

FigureI2 is a diagramatic illustration of the fabric of Figure II when folded.

Description of Preferred Embodiments

The fabric illustrated in Figures I to 3 may be knitted on a weft knitting machine which has two opposed arrays of knitting needles and is thus capable of knitting double jersey structures, for example a flat V-bed knitting machine, a double jersey circular knitting machine or a fully-fashioned knitting machine with two opposed arrays of needles.

A double jersey structure for a weft knitted fabric according to the invention must be such that a linear region can be formed in it to produce a fold line in the fabric. Double jersey structures such as I × I rib and 2 × 2 rib constitute such structures. Milano and half-milano structures may be useful, in some circumstances at least.

Figure I illustrates diagrammatically a cross-section through the loop structure of a weft knitted fabric I0 according to the invention. The bulk of the fabric is formed in a double jersey structure, I × I rib, which can be seen in regions II of the fabric. In spaced linear regions I2 and I3 of the fabric fold lines are formed by adapting the knitted structure so that, in each of these linear regions I2 and I3, the balance of the rib structure is broken and loops are pulled, in the linear region, to one face of the fabric only. The two arrays of needles of a flat V-bed knitting machine are indicated in Figure I by the two rows of points I4 and I5. Over the major part of the fabric I0 in Figure I, knitted loops I6 are pulled alternately to the front face I7 and to the back face I8 of the fabric, that is loops I6 are formed alternately on needles I4 of the front needle bed of the machine and on needles I5 of the back needle bed of the machine. In the two linear regions I3 of the fabric I0 shown in Figure I, however, the balance of the fabric is broken and a needle I4 on the front bed is left devoid of knitted loops so that in

each knitted course two adjacent loops are pulled to the back face of the fabric. Thus, in the linear regions 13, loops are pulled to the back face of the fabric only, the balance of loops in the front and rear faces of the fabric in the regions 13 may, however, be broken by using other unbalanced stitch structures instead of a complete change from double jersey to single jersey fabric.

Each region 13 may be regarded as having a width equal to the gap 21 between a pair of adjacent wales in the fabric 10 (which is of course the same as the gap between adjacent loops 16) but it might also be considered to have a width equal to one loop 16 since it is created by omission of one such loop from the front face 17 of the fabric in each course of the fabric.

In each of the two linear regions 12 constituting a fold line shown in Figure 1, the balance of the rib structure is broken by leaving two adjacent needles 15 of the back needle bed free of knitted loops so that in each region 12 three adjacent loops 16 of each course of knitting are pulled to the front face 17 of the fabric. Each linear region 12 may be regarded as having a width equal to two wale spacings and one loop 16 or equal to two knitted loops 16 and one wale spacing.

In the fabric 10 shown in Figure 1, the spacing of linear regions 12 and 13 is not constant and the reason for this will be explained with reference to Figures 2 and 3. The fold lines at the linear regions 13 in the fabric of Figure 1 have a natural angle of fold of 90°, that is, with little constraint or support, the fabric 10 will tend to fold at an angle of 90° along the regions 13. At the wider regions 12, the fabric tends to fold at an angle of 180°. Thus, the fabric of Figure 1 embodies, at spacings of long and short intervals linear regions at which it tends to fold at 90° and linear regions at which it tends to fold at 180o This structure is illustrated in Figure 2 where the wider fold regions 12 are shown containing two empty needles 15 and the narrower fold regions 13 are shown containing one empty needle 14. Figure 2 shows a complete diagrammatic cross-section of a piece of fabric 10 whereas Figure 1 shows only a part of the piece of fabric. The numbers of loops shown in various regions of the fabric 10 in Figure 1 are entirely nominal and do not correspond to the numbers of loops which would be found in an actual fabric. However, the spacing of the linear regions 12 and 13 in the fabric is such that the fabric is divided in the course-wise direction (Figure 2) into regions 22,23,24 and 25, which may be designated as having a width 2x, and into regions 26,27,28 and 29 which will then be designated as having a width x. Further, the orientation of the unbalancing of the knitted structure in the linear regions 12 and 13 determines the direction in which the fabric 10 will tend to fold at the linear region concerned. If loops are omitted from the structure in the back face 18 of the fabric, the fold will take place about a line in that face, that is, in Figure 2, the fabric region 22 will tend to fold clockwise through 180° onto the upper (back) face 18 of the fabric region 26 (which it will overlap) The fabric region 26 on the other hand will tend to fold anti-clockwise in Figure 2 to extend downwards in the Figure at right angles to the fabric region 23.

Thus, the piece of fabric 10 shown in Figure 2 is easily formed, by allowing it to fold naturally at the linear regions 12 and 13, into the fabric reinforcement having an I-shaped cross-section shown in Figure 3. After impregnation of the reinforcement of Figure 3 with a synthetic resin followed by curing, a composite element with a I-shaped cross-section can be produced.

In the fabric 10 of Figures 1, 2 and 3, the linear regions 12 and 13 are straight and extend in the wale direction of the fabric. Curved linear regions constituting fold lines may be formed in the fabric by altering the stitch structure as the knitting progresses so that the region or regions of unbalance in the fabric, where, in the present case, loops are pulled to one face of the fabric only, shifts progressively across the fabric. Provided that that shift is not too pronounced so that a reasonably gentle curve is imparted to the fold line the fabric will still be foldable at that line if the knitted structure is sufficiently loose to allow it.

Fold lines extending in the course direction of the fabric may also be formed in reinforcement according to the invention. When the basic fabric structure is a double jersey structure (which is, of course, knitted on needles of both needle arrays), a knitting machines must be used in which loops can be transferred between needles of the opposed needle arrays. To form a course-wise fold line all loops are transferred from one needle array to the other and one or more courses are knitted on the said other needle array only before continuing knitting in the basic fabric structure, if necessary transferring loops back to the empty needles of the said one needle array.

Figures 4 to 9 illustrate in cross-section a number of reinforcements formed from fabric according to the invention.

Figure 4 is a reinforcement which is cross-shaped in cross-section formed from a fabric having seven fold lines spaced at equal intervals in the fabric and all having a knitted structure such that if the fabric is folded in accordance with its natural tendency the shape shown is produced.

A reinforcement having the cross-section of a box girder, that is a rectangular cross-section, is shown in Figure 5. The reinforcement of Figure 6 has a U-shaped cross-section and that of Figure 7 a cross-section in the form of an inverted T.

Figures 8 and 9 show reinforcements having, as shown, a corrugated configuration which might serve as a basis for panelling elements or supports for flooring, that is, they might serve as reinforcements for sheet material.

A warp knitted fabric according to the invention is shown in Figures 10 to 12. The fabric is knitted on a twin needle bar Raschell warp knitting machine using five guide bars which may be designated L1 to L5 in the direction from front to back of the machine. The guide bars are threaded in the following pattern:-

L1: Thread 12, miss 1, thread 12, miss 1, thread 12.

L2: Thread 25, miss 1, thread 12

L3: Thread 12, miss 1, thread 12, miss 1, thread

12.

L4: Thread 12, miss 1, thread 25

L5: Thread 12, miss 1, thread 12, miss 1, thread 12.

In the lapping diagram of Figure 10, alternate horizontal rows of points indicate knitting operations on the front and back beds alternately. The guide bar L2 supplies yarn exclusively to the front needle bed of the machine to form the face fabric 35 (Figure 11) and it will be seen that since one eylet of the guide bar 12 is unthreaded ("miss" in the threading set-out) a gap 36 is left in this fabric. Similarly, the guide bar L3 supplies yarn exclusively to the rear needle bed to form the face fabric 37 with a gap 38 left in it. The guide bar L3 supplies yarns 39 laid to extend longitudinally between the face fabrics 35 and 37 to provide longitudinal strength in the fabric. The guide bars L1 and L5 each supply yarns alternately to the front and back needle beds providing connecting yarns 40 between the face fabrics 35 and 37 shown only diagrammatically in Figure 11. The total fabric 41 is thus made up of the face fabrics 35 and 37 and the interconnecting yarns 40 together with the strengthening yarns 39. Because of the gaps 36 and 38 in the face fabrics 35 and 37, the fabric folds naturally at the linear regions constituted by these gaps which thus constitute natural fold lines in the fabric. Because the gaps 36 and 38 are formed in opposite face fabrics, the fabric 41 will tend to fold in opposite directions at the two gaps in the manner shown in Figure 12 where it is seen that the fabric folds in each case around the gap, that is the gap is on the inside of the bend formed at the fold.

The natural angle of the fold will depend on the nature and thickness (decitex) of the yarn used and on the modulus of the yarn used, that is for the same geometric configuration of loops in the fabric and yarn in the loops, the angle of fold will be proportional to the modulus. Further, it will be dependent on the number of needle spacings encompassed, that is on the number of knitted loops corresponding to the gap width. The greater the number of thread ends omitted at a gap the greater the natural angle of fold will be. Normally up to three thread ends omitted (empty needles) at the gap will be sufficient to achieve at 180° fold.

It will be seen that by adjusting the threading of the guide bars the dimensions of the fabric parts can be adjusted as well as the direction and angle of folding and numerous reinforcements can be made, for example reinforcements as illustrated in Figures 3 to 9.

If strength requirements in the final product require it, each of the shaped reinforcements illustrated can include a plurality of layers of folded fabric. Two such layers are in fact shown in Figure 5 and two (or more) layers can be employed for the shapes shown in Figures 3, 4, 6-9 and 12. The box girder reinforcement of Figure 5 can be continued in spiral fashion to provide more than two layers in the final reinforcement produced.

Any of the conventionally available filamentary materials including glass, carbon, graphite, boron, silicon carbide and high performance aromatic polymers (such as the material known under the Trade Mark "Kevlar") can be used for knitting the reinforcements described herein.

Claims

1. A knitted fabric (10,41) adapted to serve as reinforcement for a composite element, characterised in that the fabric (10,41) has at least one linear region (12,13,36,38) structured so as to constitute a natural fold line in the fabric so that by folding the fabric at the or each of the said lines (12,13,36,38) it can be formed into a configuration suitable for a composite element reinforcement.

2. A knitted fabric as claimed in claim 1 comprising at least two fold lines having widths corresponding to different numbers of knitted loops.

3. A knitted fabric as claimed in claim 1 or 2, wherein the said fold line or lines extend in the wale direction.

4. A knitted fabric as claimed in claim 1 or 2, wherein the said fold line or lines extend in the course direction.

5. A knitted fabric as claimed in claim 1 or 2, wherein the said fold-line or at least one of the said fold lines is curved.

6. A knitted fabric as claimed in any one of claims 1 to 5, wherein the said fabric has a weft knitted double jersey structure and a linear region (12,13) constituting a fold line comprises a region in which the balance of loops in the two fabric faces of the double jersey fabric is broken.

7. A knitted fabric is claimed in claim 6, wherein in the said region the balance of loops is broken in that loops are pulled to one face of the fabric only.

8. A reinforcement for a composite element characterised in that it comprises a fabric as claimed in any one of the preceding claims.

9. A composite element including reinforcement comprising a knitted fabric (10,41) characterised in that the knitted fabric (10,41) has at least one linear region (12,12,36,38) structured so as to constitute a natural fold line in the fabric, the fabric being folded at the or each of the said fold lines to form it to such a configuration that it is adapted to serve as reinforcement in the composite element.

10. A composite element as claimed in claim 9, wherein the said fold line or lines in the knitted fabric extend in the wale direction.

11. A composite element as claimed in claim 9, wherein the said fold line or lines in the knitted fabric extend in the course direction.

12. A composite element as claimed in claim 9, wherein the said fold-line or at least one of the said fold lines in the knitted fabric is curved.

13. A composite element as claimed in any one of claims 9 to 12, wherein the said knitted fabric has a weft knitted double jersey structure and a linear region (12,13) constituting a fold line

comprises a region in which the balance of loops in the two fabric faces of the double jersey fabric is broken.

14. A composite element as claimed in claim 13, wherein in the said region the balance of loops is broken in that loops are pulled to one face of the fabric only.

15. A reinforcement for a composite element, characterised in that it comprises a fabric as claimed in claim 1, folded to a configuration having a cross-shaped cross-section.

16. A reinforcement for a composite element characterised in that it comprises a fabric as claimed in claim 1 folded to a configuration having a rectangular cross-section.

17. A reinforcement for a composite element characterised in that it comprises a fabric as claimed in claim 1 folded to a configuration having a U-shaped, cross-section.

18. A reinforcement for a composite element characterised in that it comprises a fabric as claimed in claim 1 folded to a configuration having an I-shaped cross-section.

19. A reinforcement for a composite element characterised in that it comprises a fabric as claimed in claim 1 folded to a configuration having a T-shaped cross-section.

20. A reinforcement for a composite element characterised in that it comprises a fabric as claimed in claim 1 folded to a configuration having a corrugated cross-section.

Fig.1.

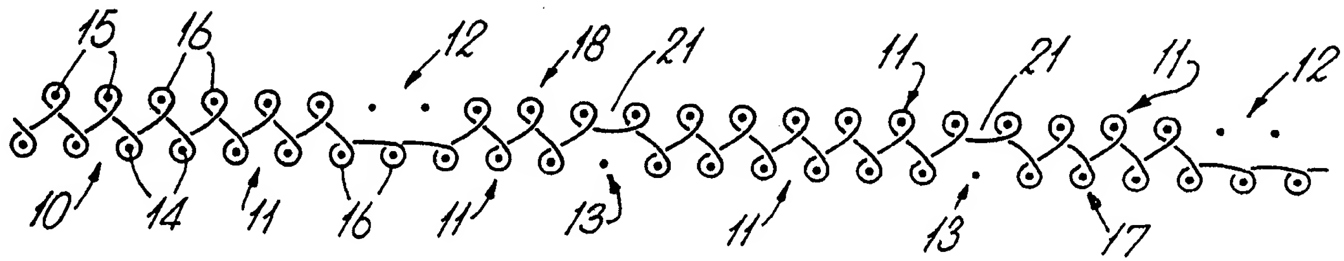


Fig.2.

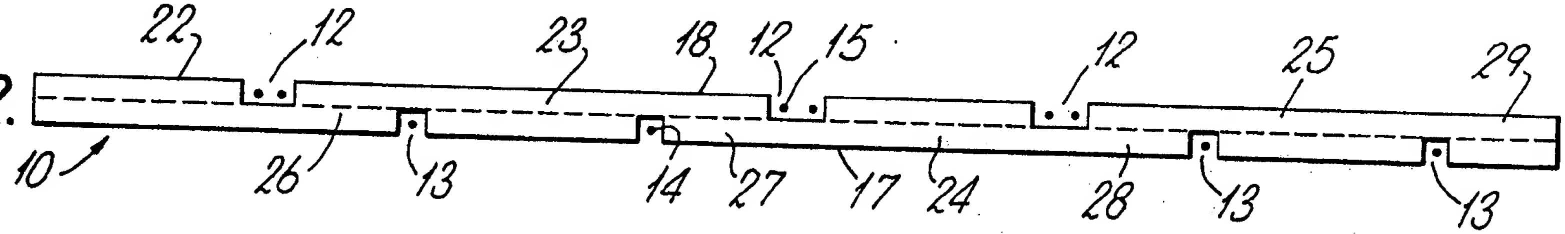


Fig.3.

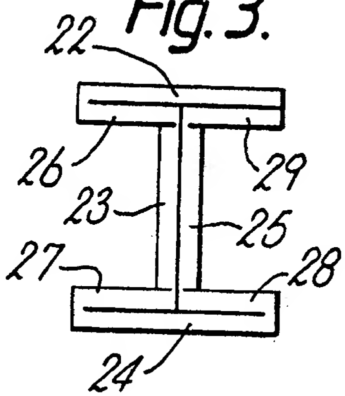


Fig.4.

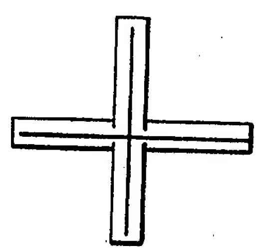


Fig.5.

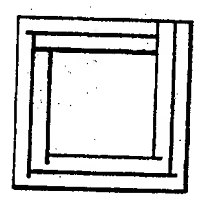
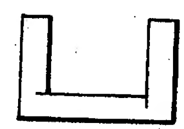


Fig.6.



0243105

Fig.7.

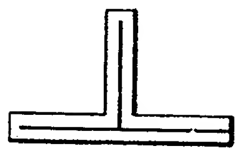


Fig.8.

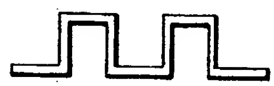


Fig.9.

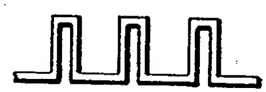


Fig.10.

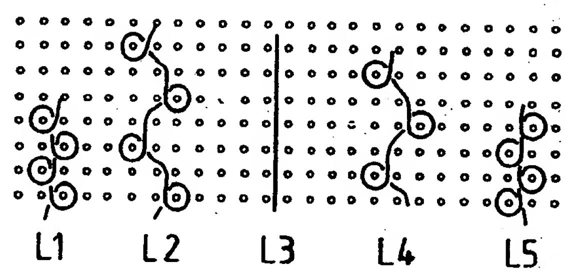


Fig.11.

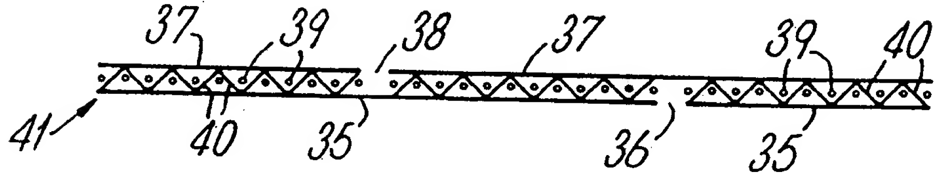
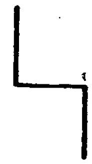


Fig.12.



European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87 30 3383

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-2 201 980 (ARTZT) * Page 2, right-hand column, lines 52-63; figures 1-4 * ---	1-3,6,7	D 04 B 1/00 B 29 C 67/14
X	DE-B-2 012 733 (INTER-JERSEY) * Column 4, line 1 - column 5, line 51; figures 1-12 * ---	1-3,6-10,13,14,20	
A	US-A-3 045 319 (SCHEEL) * Column 2, lines 1-19; figures 1-4 * ---	1,2,9,16	
A	US-A-3 934 064 (LOWTHIAN) ---		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	DE-A-2 927 414 (GULF STATES PAPER CORP.) -----		D 04 B B 29 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-08-1987	VAN GELDER P.A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document